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Reprinted from Vol. 21, Page 854, September, 1929

Industrial and Engineering Chemistry

Published by the American Chemical Society

Some Scientific Aspects of Packaging and Quick- Freezing Perishable Flesh Products

III—Sanitary Measures in a Fish Dressing Plant¹

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THERE are many different kinds of fish, and each may be dressed and packaged in a number of ways. This article deals primarily with the production of quick-frozen packaged haddock fillets in a thoroughly modern plant at Gloucester, Mass. Obviously, however, much of the information given herein is more or less directly applicable to other seafood products and methods of packaging.

Fish is one of the most perishable of flesh products, both bacterial and autolytic decomposition taking place rapidly even at comparatively low temperatures. Different kinds of fish can support various amounts of bacterial infection before becoming unfit for food: haddock, mackerel, and sole lose their fresh flavor when a count of 1,000,000 to 4,000,000 per gram, as determined by the method later described, has been reached (Table I). Autolysis, instead of rendering seafoods tender and juicy, as is the case with meats, gives rise to a sour, "fishy" flavor that is decidedly objectionable.

Handling Haddock, from Water to Shipping Container

Off the New England coast haddock are caught in a variety of ways; but, once caught, the method of handling and preserving them until landed ashore is much the same for all kinds of fishing.

The haddock are first slit down the abdomen from the gills to the vent, and the viscera removed. They are then thoroughly rinsed in a tub of seawater, and passed—none too

¹ Received June 11, 1929.

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gently—into the fish-hold, where they are packed with a generous quantity of crushed ice into numerous comparatively small bins so arranged as to prevent undue bruising of the

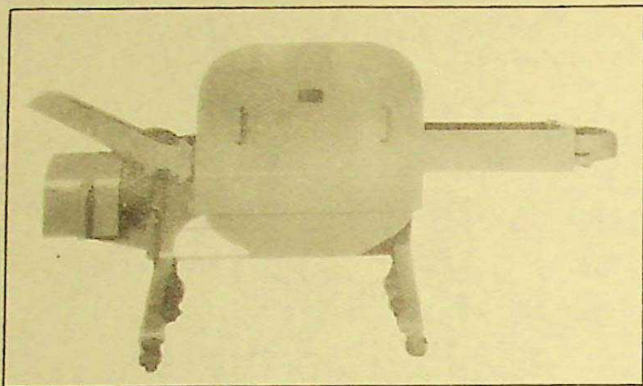


Figure 1—Automatic Scaler—Handles Fish of Any Size at Rate of 35 per Minute

fish by their own weight or because of the movement of the boat during rough weather.

When the boats dock, the fish are hoisted out of the hold, usually in 100-pound canvas baskets, and dumped into a

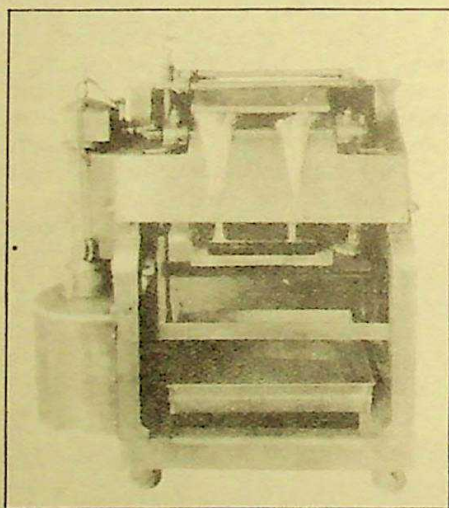


Figure 2—Fish-Skinning Machine,
Discharge Side

wash tank of running seawater, which removes much of the slime, ice, and other extraneous matter. An automatic conveyor carries the fish from the wash tank and deposits them in a wooden box, in one side of which is a hinged door.

These boxes hold 600 pounds net weight of fish. A layer of crushed ice is placed on the bottom of the box; another is applied when the box is half full; and a third is placed over the top of the filled box. After being filled, the iced boxes are immediately hauled to the receiving end of the fish-dressing plant, and placed in an insulated room mechanically cooled to 37° F. (about 3° C.) where they are held—sometimes as long as 48 hours—until placed in process.

Table I—Spoiling Point of Fresh Fish

KIND OF FISH	FIRST COUNT		AFTER 24 HOURS	AFTER 98 HOURS
	Date	Count		
	1927			
Haddock	July 29	29,000	2,540,000 SS	
Haddock	Oct. 13	46,000		8,350,000 S
Haddock	Oct. 13	29,000		6,950,000 S
Haddock	Oct. 15	15,300	197,000 F	
Haddock	Oct. 17	18,000		5,500,000 SS
Haddock	Oct. 19	24,300	390,000 F	7,200,000 S
Haddock	Oct. 20	28,000	800,000 F	6,630,000 S
Haddock	Oct. 22	38,600	3,050,000 SS	
Mackerel	Oct. 24	17,300	1,040,000 F	4,900,000 AS
Gray Sole	Oct. 24	15,500	1,073,000 F	6,450,000 SS
Lemon Sole	Nov. 1	58,000		9,000,000 S
Lemon Sole	Nov. 4	35,300		4,700,000 S
Dab Sole	Nov. 1	34,000		2,950,000 S
Dab Sole	Nov. 4	35,000		5,600,000 S
Dab Sole	Nov. 5	35,500	255,000 F	2,700,000 AS

All material consisted of quick-frozen (Birdseye system) packaged fillets, removed from cold storage after approximately 48 hours at -26° C. Material for first count taken while product was still hard-frozen. Fillets then wrapped loosely with waxed vegetable parchment paper and held at an average room temperature of about +20° C. The symbols F, AS, S, and SS designate the condition of the samples, respectively, as fresh, almost spoiled, spoiled, and putrid. Counts are per gram.

When the fish are to be started through the dressing process, the boxes are removed from temporary storage and their contents dumped, through the hinged door in the side of the box, into the hopper of the scaling machine, where the scales are removed under a spray of seawater (Figure 1). From the scaler the fish pass automatically through a series of three washing tanks, through all of which seawater is circulated. A conveyor carries the washed fish to the cutting tables, where the fillets are removed by hand operators.

From the cutting tables the fillets are carried to the skinning machine (Figure 2), which operates under a spray of seawater; and thence the skinned fillets pass over an inspection conveyor (Figure 3), which in turn passes the selected fillets into the brining machine (Figure 4), where they are given a few seconds' immersion in a weak sodium chloride brine.

Note—Some fillets are scaled and not skinned, others are skinned but not scaled. Both the scaling and skinning machines are never used on the same product.

After leaving the brine bath, the fillets are conveyed in monel metal pans to the monel-topped packing tables, where they are individually trade-marked and wrapped in Moisture-proof Cellophane and assembled in 10-pound cold-waxed cartons. These, after being frozen with extreme rapidity between endless metal belts (Figure 5), are placed in insulated corrugated fiber board containers, for storage or shipment.

Important Factors Causing Bacterial and Autolytic Spoilage

The flesh of live fish is usually nearly or quite sterile; but the digestive tract, unless absolutely empty of food, is highly infected. The slime on the surface of the fish is usually some-

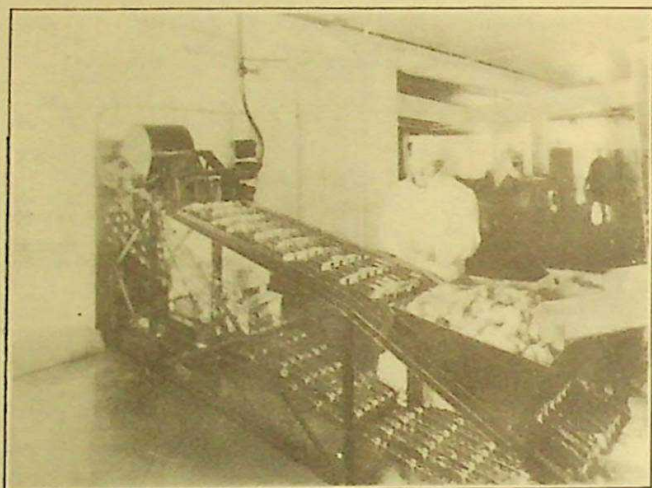


Figure 3—Fillet Inspecting and Cutting Conveyor

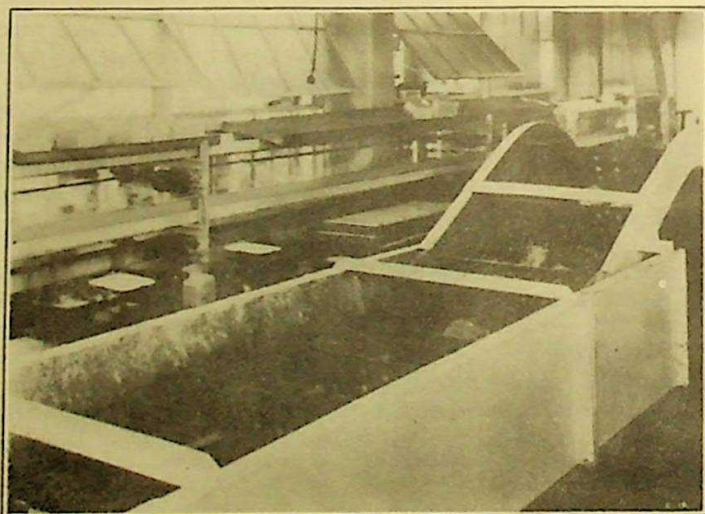


Figure 4—Brining Machine

what infected when the fish leaves the water and invariably becomes more so shortly afterwards. When the fish are eviscerated, bacteria from the broken digestive tract and from the operator's knife are smeared on all cut or scratched sur-

faces. The gills quickly become heavily infected and the infection spreads throughout the body by way of the circulatory system. Moreover, although the fishholds, baskets, and deck are flushed and scrubbed frequently with seawater, they are almost always highly infected, and the count on the fish is further built up by contact with them and with the hands and boots of the fishermen. Infection is carried from one fish to another by the water from the melting ice.

Not all parts of the body are equally infected when the fish reaches the processing floor. Almost invariably the kidney, which lies between the air bladder and the backbone, has a very high count. The napes (or flanks) are usually the most highly contaminated part of the edible flesh. The meat on each side of the backbone and that toward the tail is usually freest of bacteria (Table II).

Table II—Comparative Bacterial Infection of the Nape (Flank), Back, and Tail Flesh of Fresh Haddock

HOURS AFTER DEATH	COUNT PER GRAM		
	Nape	Back	Tail
1	24,800	None	140
48	159,000	None	None
96	197,000	580	70

Fish eviscerated immediately after being caught, but not packed in ice until after sample for first count was taken. Thereafter fish kept in crushed ice in storage room held mechanically at 3° C. Samples taken from flesh under skin. "Tail" sample taken from side of fish about 3 inches from base of tail.

As the fish progresses from process to process through the plant, infection of the outer surfaces of the fillets is constantly built up—from contact with conveyors, tables, knives, pans, air, operators' hands, and other sources—for it is commercially impractical to keep the apparatus in a fish plant constantly sterile (Table III).

Autolysis, of course, commences very soon after death and proceeds with great rapidity, unless the fish are kept very cold. It is hastened by bruising caused either when the fish is caught or by rough handling aboard ship and in the plant, the use of too large lumps of ice, and icing the fish in too large masses. Sometimes, under exceptional circumstances, advanced autolysis may render fish unfit for food even though the bacterial count may be low.

Sanitary Control Measures

Strongly chlorinated seawater is used lavishly throughout the plant, and has proved most satisfactory since, in addition to acting as a powerful disinfectant, it removes bacteria and infected particles mechanically and keeps the apparatus from clogging up with scales and sticky particles of flesh. No fresh water or unchlorinated seawater is used. The water is taken from the outer harbor, and chlorinated to about 7 p. p. m. on the suction side of the pump. Depending on the amount of organic matter in the water—greatest at low tide, in rough weather, and in summer, and

least at high tide in calm weather—this dosage leaves a residual of about 5 p. p. m. of free chlorine when the water reaches the 10,000-gallon tank in the tower of the factory. The pumps are kept going 24 hours a day, any surplus water

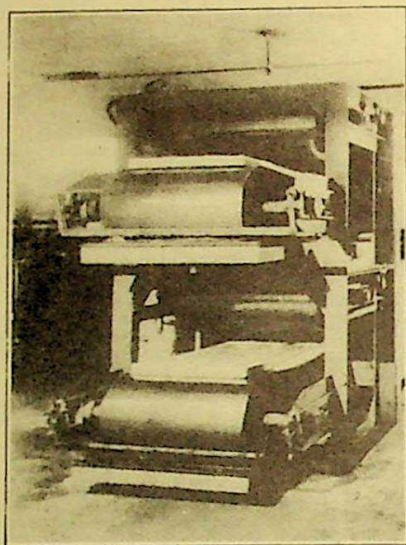


Figure 5—Birdseye Quick-Freezing Machine

Packaged product to be frozen is seen on broad metal belts, being carried into insulated tunnel where calcium chloride brine at 45° below zero is sprayed on top of upper belt and bottom of lower belt. Product emerges as a solid block of frozen material.

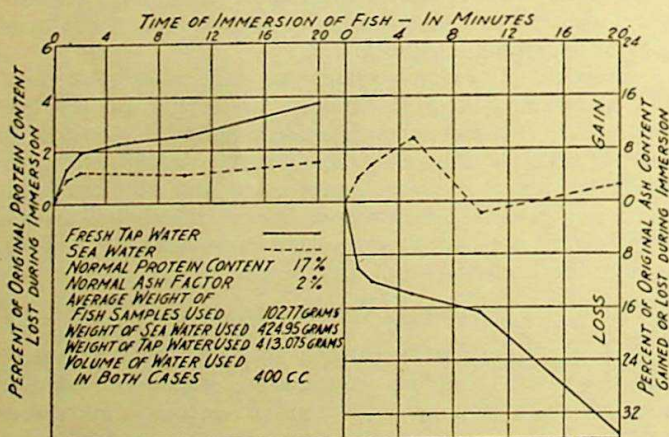


Figure 6—Protein and Ash Gained or Lost by Fish after Immersion in Fresh and Sea Water

not required by the plant operations being run back into the harbor. A freshly chlorinated supply of sterile seawater is thus assured for the plant at all times—for dressing operations during the day and clean-up work at night. By the

time the water reaches the wash tank on the receiving wharf and the several machines on the dressing floor, the content of free chlorine has dropped to from 1 to 3 p. p. m. This strength is sufficient to reduce greatly the surface count during the several operations, but frequent examinations have proved that it has little, if any, effect on the bacteria under the scales, in the center of the gill clusters, and in the flesh.

Some interesting experiments were carried on to determine the relative effect of fresh and sea water when applied to fish during various stages of the dressing operation. It was found that fresh water removes from the flesh a considerable percentage of cold-water-soluble proteins and salts, but that the sea-water gives up some of its salts to the fish, and by partially coagulating the protein at the surface of the fillets greatly lessens the absorption of protein by the water (Figure 6).

Table III—Progressive Infection and Disinfection during Dressing Operations

PROGRESS THROUGH PLANT	COUNT PER GRAM			
	Slime	Nape	Surface	Flesh
Eviscerated fish, as taken from boat	3,021,000	1,035,000		
After passing through wash tank, on wharf	778,000	451,500		
After remaining in crushed ice 48 hours	1,853,000	1,240,000		
After passing through 3 wash tanks at plant	1,040,000	700,000		
Fillets, after being skinned (by hand)			1,400,000	153,900
Before entering brining machine, and after standing $\frac{1}{2}$ hour in pan, with other fillets			2,066,000	144,800
After leaving brining machine			644,000	97,600
After being packaged, and held at -2.5° C. for 12 hours				77,450
After being quick-frozen				31,950

To lessen contamination of the liquid in the brining machine, the fillets, just prior to entering that apparatus, are given a needle spray of chlorinated seawater, which removes a large proportion of any scales, loose particles of flesh, and surface bacteria which may have become attached to the fillets during the next previous operation. The brine itself—a light solution of sodium chloride—is treated hourly with a measured quantity of sodium hypochlorite, so that it constantly contains from 1 to 3 p. p. m. of free chlorine (Table IV); and the fillets emerging from this apparatus are in excellent condition to be packed into the individual one-pound cartons or wrapped in transparent Moistureproof Cellophane and deposited in the 10-pound dealer packages (Table V).

Throughout the plant all surfaces with which the product may come in contact are smooth, non-porous, and easily cleansed. Floors are of granolythic concrete, sloped to frequent drains. Walls are enameled white, with a 5-foot dado of gray enamel, and a sanitary coping. Ceilings, also, are

white. Inner walls and ceilings of refrigerated rooms are of mastic finish enameled white. All equipment is of monel metal, aluminum, bronze, galvanized iron, nickel-chromium alloy, or chromium plating, each material being used where extended research and much expensive experience has indi-

GENERAL SEAFOODS CORPORATION

P. O. No. 973

DATE 4-1-29

PURCHASE RECORD					PRODUCTION REPORT		
DATE PURCHASED	LOT NO.	LOT NO.	LOT NO.	LOT NO.	DATE PACKED 3-31-29	P. O. No.	
DATE CAUGHT	758	769			FILLETS	NO. POUNDS	PERCENTAGE
NO. POUNDS	3/29	3/30			Fillet Had.	290	0.6
KIND	40,000	12,000			Fillet LOAF	260	0.5
SIZE	Had'k	Cod			CELLO WRAPPED Fillets	14,800	44.6
GEAR USED	Med.	Large			Had. Squares	455	.9
GROUNDS	O.T.	O.N.			Cod File	5,040	42.0
WHERE PURCHASED	So. Chan.	Thatch.			TOTAL		
TRANSPORTED	Gloue.	Gloue.			BRINE STRENGTH	Had. - B	TIME BRINING 6 MIN.
REMARKS	Tractor	Truck				Cod - A	
					REMARKS	Squares - A	
	Gen. No. 1	7,308					
	2	2,356					
	3	2,328					
	4	4,607					
	5	18,761					
SIGNED	6	2,640					
		42,000					

LABORATORY REPORT

BACTERIOLOGICAL REPORT			KITCHEN REPORT				
WORK BY	DATE		COOKED BY	DATE			
KIND	COUNT			FILLETS	Cod FILLETS	FILLET LOAF	Squares
HADDOCK FILLETS	30,160		APPEARANCE	A-	A	A	A-
SOLE FILLETS			ADHESIVENESS			A	A
MACKEREL FILLETS			LEAKAGE	A	A	A	A
FILLET LOAF	32,000		CONSISTENCY			A	A
CELLO WRAPPED	21,600		COHESION			A	A
Cod File	19,300		SHRINKAGE	A	A	A	A
			TENDERNESS	A	A	A	A
			FLAKINESS	A	A		A
REMARKS			FLAVOR	A	A	A	A
			REMARKS	1. Very small blood clot not removed.			
				2. One bone found.			
SIGNED							

Figure 7—Lot History Sheet

cated that it renders the best service. Table tops are of monel. Belts on the quick-freezing machines are of monel or stainless steel. Pans for holding partially processed product are of monel.

Monel pans in which fillets are supplied to the packing tables are, during working hours, kept standing in a strong (7 p. p. m.) sodium hypochlorite solution when not in use, and every night are given a thorough scrubbing in the same strength solution.

When operations at the Gloucester plant were first started, the girl packers wore rubber gloves; but it was found a practical impossibility to prevent particles of fish adhering to the gloves, and the packers now wash their hands in chlorinated seawater before starting work and at frequent intervals during the day.

Table IV—Effect of Chlorinating 35° Salinometer Sodium Chloride Brine, in Brining Machine

TEST	COUNT PER CUBIC CENTIMETER ^a		PER CENT REDUCTION
	Before chlorinating ^b	After chlorinating ^c	
1	320,000	1,450	99.54
2	213,500	1,350	99.36
3	245,000	27,000	88.97
4	170,000	Sterile	100.00
Average	237,100	7,450	96.85

^a Method of counting: In making a count on fish flesh a comparatively large sample—usually 10 grams—is macerated with knives and forceps and placed in a flask with 100 cc. of sterile water, which is later further diluted sufficiently to assure ease of counting. One cubic centimeter of the diluted sample is plated on Bacto Nutrient Agar, and incubated 48 hours at 20° C. The count is recorded in bacteria per gram of fish. In making a count on fish slime or other liquids or fluids, the method is the same, except that the results are given as bacteria per cubic centimeter of sample.

^b Freshly-mixed brine, through which fillets had been passed for about 6 hours, before the samples were taken. Average temperature about 13° C.

^c Chlorination accomplished by adding sodium hypochlorite to bring residual chlorine content to about 5 p. p. m. Counts in this column represent average of samples—the clear liquid was in all cases sterile, but there were many small particles of flesh, mucous, etc., which apparently had not yet been sterilized by the action of the chlorine, which was added 15 to 20 minutes prior to sampling.

Table V—Effect of Passing Haddock Fillets for 20 Seconds through 35° Salinometer Sodium Chloride Brine Chlorinated to 5 p. p. m. of Residual Chlorine by Addition of Sodium Hypochlorite

TEST	COUNT PER GRAM		PER CENT REDUCTION
	Before brining	After brining	
1	111,000	77,000	30.63
2	236,000	114,000	51.65
3	1,790,000	413,000	76.92
Average			53.06

During working hours a janitor constantly flushes floors and machines with chlorinated seawater, and at night everything is scrubbed and washed down with a high-pressure automobile pump employing a strong sodium hypochlorite solution.

A well-equipped chemical and bacteriological laboratory and a testing kitchen are operated in connection with this Gloucester plant, and all product is subject to strict laboratory control. Figure 7 illustrates the "Lot History Sheet," which has been of great value in assuring a uniformly satisfactory finished product. The form consists of four sections, each of which represents one of the four phases of production

and testing. The upper left-hand section covers the history of the raw material. In the upper right-hand quarter complete manufacturing data are recorded. The lower left-hand square shows the results of a bacteriological examination of two representative samples, taken at random in the packing room, distinctively labeled, and then replaced with the regular production packages to await their return at the quick-freezing machine. The remaining section of the record shows the result of a careful cooking test of each of the products included in the day's production. No part of the production covered by any Lot History Sheet is released for shipment until the sheet has been examined and approved by a responsible member of the laboratory organization.

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